A Report on Washington, D.C.'s Urban Tree Canopy

Why is Tree Canopy Important?

Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Washington's UTC provides many environmental and social benefits, reducing storm-water runoff and the city's carbon footprint, improving air quality, providing habitat for wildlife, contributing to savings on energy bills, increasing property values, and enhancing quality of life. UTC also facilitates social and educational opportunities and provides aesthetic benefits that help define the city's "sense of place."

Mapping D.C.'s Urban Tree Canopy

An analysis of Washington, D.C.'s urban tree canopy (UTC) based on high-resolution satellite imagery found that 13,673 acres of the city is covered by tree canopy (termed Existing UTC). This corresponds to 35% of all land within the city (Figures 1 and 2). An additional 32% (12,508 acres) of the city could theoretically be improved to support urban tree canopy (termed Possible UTC). Possible UTC includes non-canopy vegetation (e.g., grass/shrubs), bare earth, and certain paved surfaces (e.g., driveways, sidewalks) that, under the right circumstances, could be modified to increase tree cover. The remaining 33% of the city's land area (13,102 acres) is generally unsuited to UTC improvement and includes buildings, roads, railroads, and other permanent developed features. Many factors determine where and when trees are planted in the urban landscape, but a UTC assessment is an essential first step: Where can trees be planted if the requisite social, financial, and political capital exists?

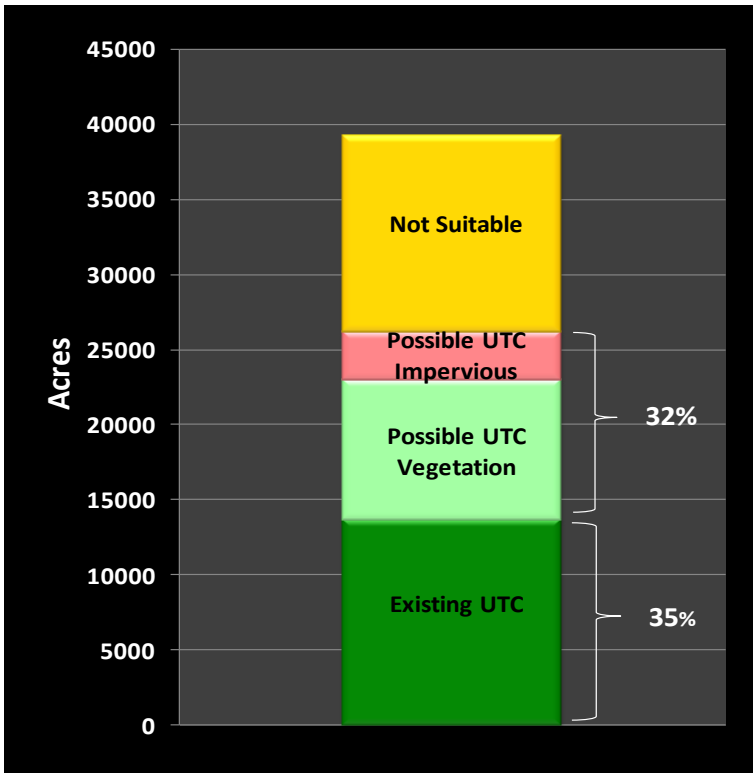

Figure 1: UTC metrics for Washington, D.C. Percentages are based on % of land area.

Project Background

The analysis of Washington, D.C.'s urban tree canopy was carried out as part of a multi-state UTC grant from the USDA Forest Service, in collaboration with the District of Columbia Government Urban Forestry Administration and the D.C. Office of the Chief Technology Officer. The analysis was performed by the Spatial Analysis Laboratory (SAL) of the University of Vermont's Rubenstein School of the Environment and Natural Resources, in consultation with the USDA Forest Service's Northern Research Station.

The goal of the project was to apply the USDA Forest Service's UTC assessment protocols to Washington, D.C. This analysis was conducted based on year 2006 data.

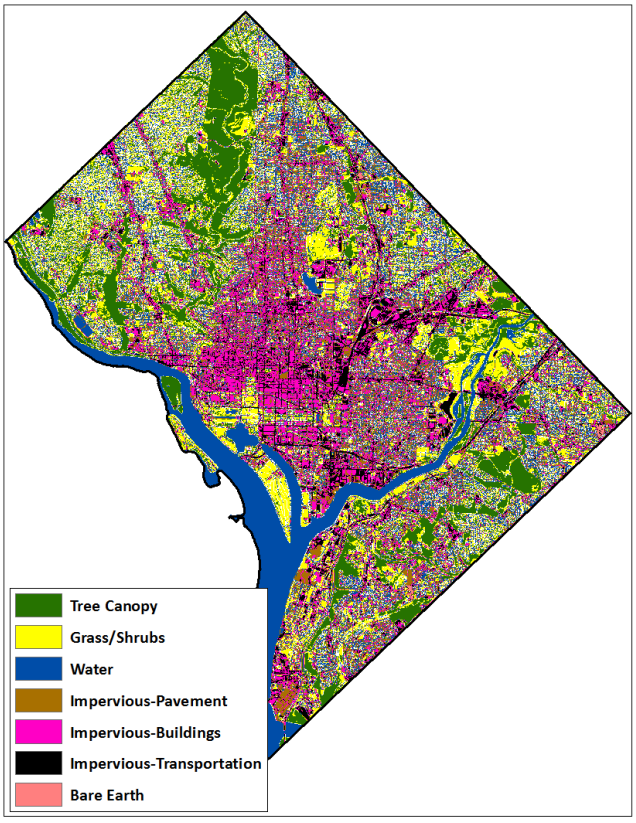

Figure 2: Land cover for Washington, D.C. Tree canopy currently covers about 35% of the city's land area.

Key Terms

UTC: Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.
Land Cover: Physical features on the earth mapped from satellite imagery such as trees, grass, water, and impervious surfaces.
UTC Metrics: Statistical UTC information summarized categorically (e.g. zoning class) or spatially (e.g. property parcels)
Existing UTC: UTC metric indicating the amount of urban tree canopy present when viewed from above using aerial or satellite imagery.
Possible UTC: UTC metric indicating the amount of land that is theoretically available for the establishment of tree canopy. Possible UTC excludes areas covered by tree canopy, roads, buildings, and water.

Ownership and Land-use Patterns

The detailed land-cover mapping conducted as part of this assessment permitted calculation of the percentage of Existing and Possible UTC for each parcel of land in Washington (Figure 3). This information provides a comprehensive overview of the existing tree canopy on each ownership unit and is an essential first step: Where are the city's trees and who owns them? It also provides the corollary analysis that is a necessary prerequisite to prioritization: Where are the parcels that could theoretically support expanded tree canopy and who owns them?

These parcel-based estimates were then combined with land-use data to examine general ownership patterns (Figures 4a, 4b, 5 and Table 1). Much of Washington's tree canopy occurs in publicly-owned parks and recreation zones (note that Federally-owned parks are included in the Parks, Recreation and Open Space land-use category). However, residential zones also contain a significant proportion of Existing UTC, particularly low– and moderate-density areas (on average, Existing UTC occupies 37% of low-density residential parcels, 16% of moderate-density residential parcels, and 11% of medium– and high-density residential parcels). Institutional and non-park Federal lands add further contributions. Interestingly, most of the land suitable for planting new trees is also in lower-density residential zones and parks/recreation zones.

The insights derived from these analyses—an understanding of city-wide ownership patterns and a database of parcels where tree planting might be beneficial—can be used by decision makers to prioritize neighborhoods for UTC-improvement programs and then target specific properties on which more trees are logistically feasible and socially desirable (Figure 6). Actual prioritization efforts will, of course, depend on many factors, but an accurate assessment of current UTC conditions is the baseline from which all subsequent analyses will be developed.

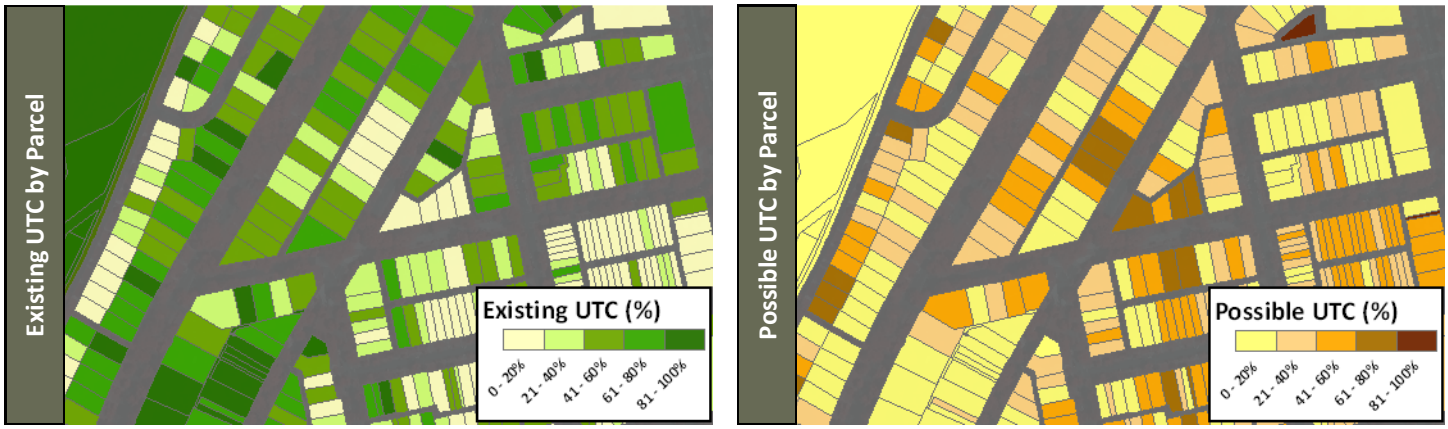

Figure 3: Existing and Possible UTC, expressed as the percentage of land area, for parcels in Washington, DC.

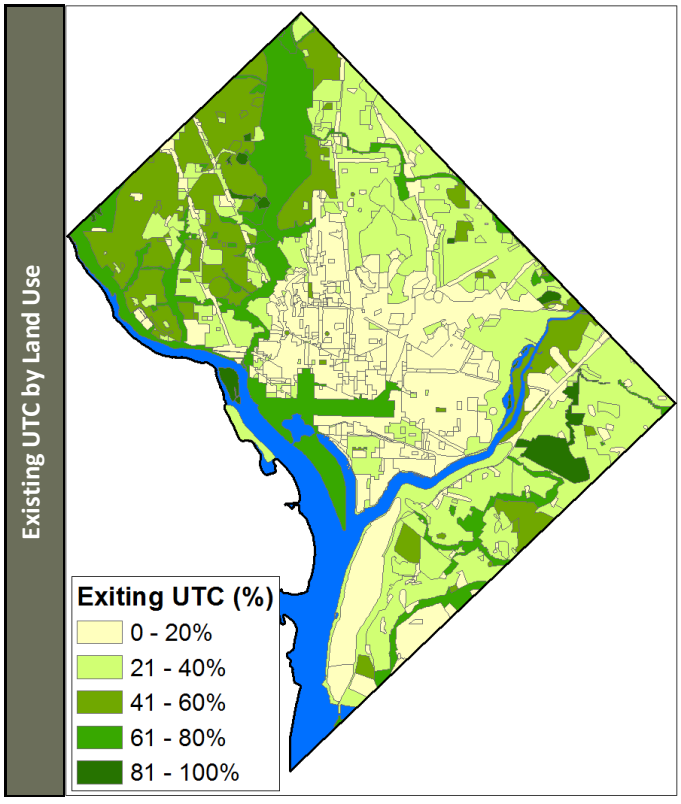

Figure 4a: Existing UTC, expressed as the percentage of land area, for land-use types.

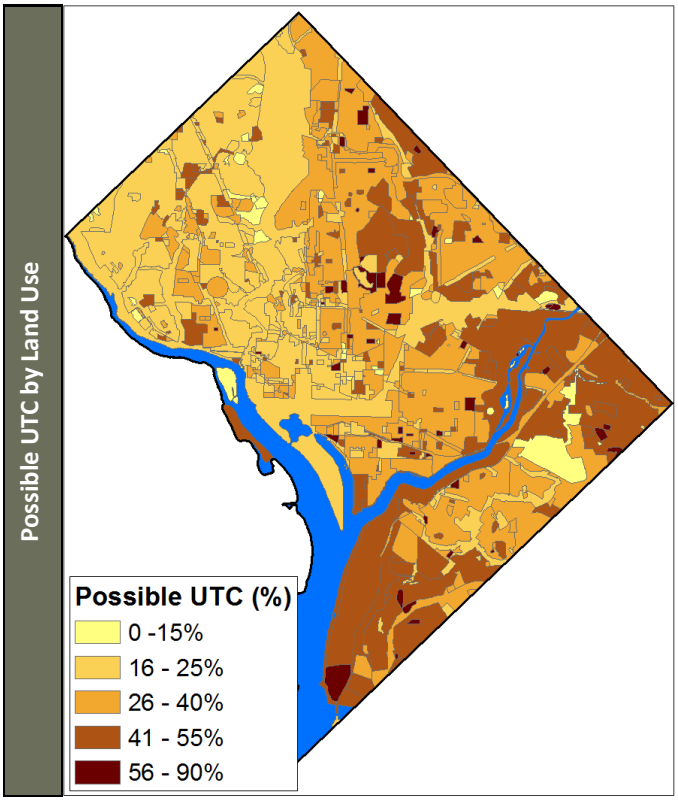

Figure 4b: Possible UTC, expressed as the percentage of land area, for land-use types.

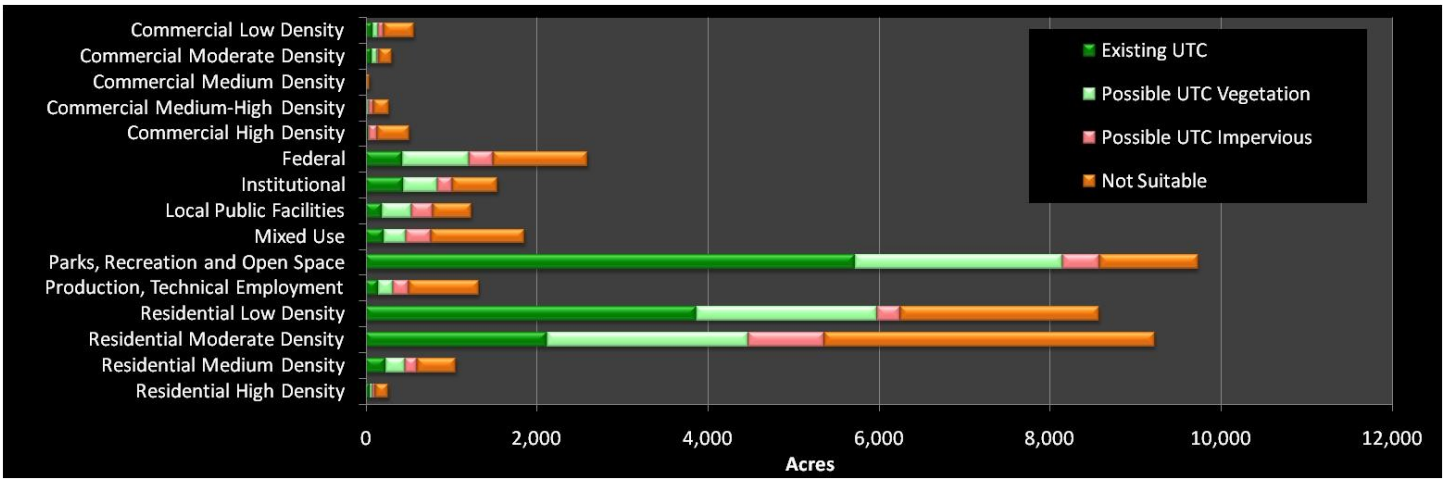

Figure 5: UTC metrics summarized by land use._ Note that the Parks, Recreation and Open Space category includes Federal parkland.

Land Use	Existing UTC			Possible UTC Vegetation			Possible UTC Impervious		
	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type
Commercial High Density	0%	6%	0%	0%	3%	0%	0%	18%	3%
Commercial Low Density	0%	15%	1%	0%	12%	1%	0%	11%	2%
Commercial Medium Density	0%	6%	0%	0%	5%	0%	0%	15%	0%
Commercial Medium-High Density	0%	7%	0%	0%	8%	0%	0%	21%	2%
Commercial Moderate Density	0%	24%	1%	0%	18%	1%	0%	9%	1%
Federal	1%	16%	3%	2%	30%	8%	1%	11%	9%
Institutional	1%	28%	3%	1%	26%	4%	0%	11%	5%
Local Public Facilities	0%	16%	1%	1%	28%	4%	1%	20%	8%
Mixed Use	1%	12%	2%	1%	14%	3%	1%	16%	9%
Parks, Recreation and Open Space	15%	59%	42%	6%	25%	26%	1%	4%	14%
Production, Technical Employment	0%	11%	1%	0%	13%	2%	0%	14%	6%
Residential High Density	0%	19%	0%	0%	14%	0%	0%	12%	1%
Residential Low Density	10%	45%	28%	5%	25%	23%	1%	3%	8%
Residential Medium Density	1%	22%	2%	1%	22%	2%	0%	13%	4%
Residential Moderate Density	5%	23%	16%	6%	26%	25%	2%	10%	28%

$$\%\ \text{Land} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all land}}$$

The % Land Area value of 10% indicates that 10% of Washington's land area is tree canopy in areas where the land use is "Residential Low Density."

$$\%\ \text{Category} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all land for specified land use}}$$

The % Land Use value of 45% indicates that 45% of "Residential Low Density" land is covered by tree canopy.

$$\%\ \text{UTC Type} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all UTC type}}$$

The % UTC Type value of 28% indicates that 28% of all Existing UTC lies in the "Residential Low Density" land use.

Table 1: UTC metrics summarized by land use. For each land-use category, UTC metrics were computed as a percent of all land in the city (% Land), as a percent of land area by land-use category (% Category), and as a percent of the area for the UTC type (% UTC Type).

Where to Plant Trees?

Decision makers can use GIS to identify specific UTC metrics for a parcel or set of parcels. This information can be used to estimate the amount of tree loss in a planned development or set UTC improvement goals for an individual property.

Attribute	Value
Land Use	Residential Moderate Density
Owner	Gethesemane Baptist Church
Address	5119 4th St. NW
Existing UTC	8%
Possible UTC	54%
Possible UTC-Vegetation	26%
Possible UTC-Impervious	28%

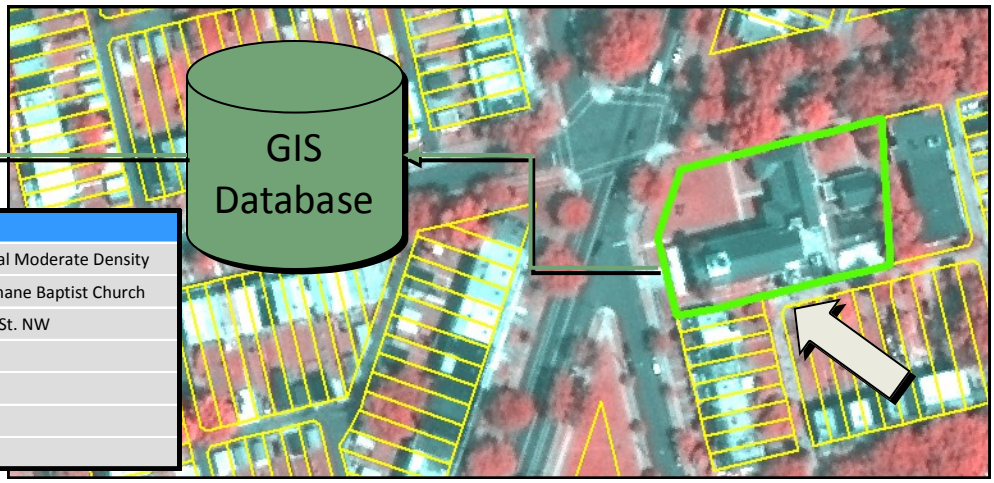

Figure 6: Parcel-based metrics can be used to support targeted UTC improvements.

Social Unit Analysis

Many additional analyses can be performed to provide further context for setting UTC priorities, including ones that focus on the social, environmental, and political dimensions of urban forestry. For social analyses, UTC data summaries can be linked to demographic data from the U.S. Census Bureau at multiple scales, including the block, block group, and tract levels. At the block group level, for example, it is apparent that the city center and adjacent neighborhoods contain comparatively little tree canopy (Figure 7a). Because many of these blocks groups are likely occupied by buildings and other permanent infrastructure, they also contain lower volumes of Possible UTC (Figure 7b). When block group data and UTC metrics are examined statistically, relationships between tree canopy and socioeconomic trends become discernible (Figure 8), providing additional information for UTC prioritization.

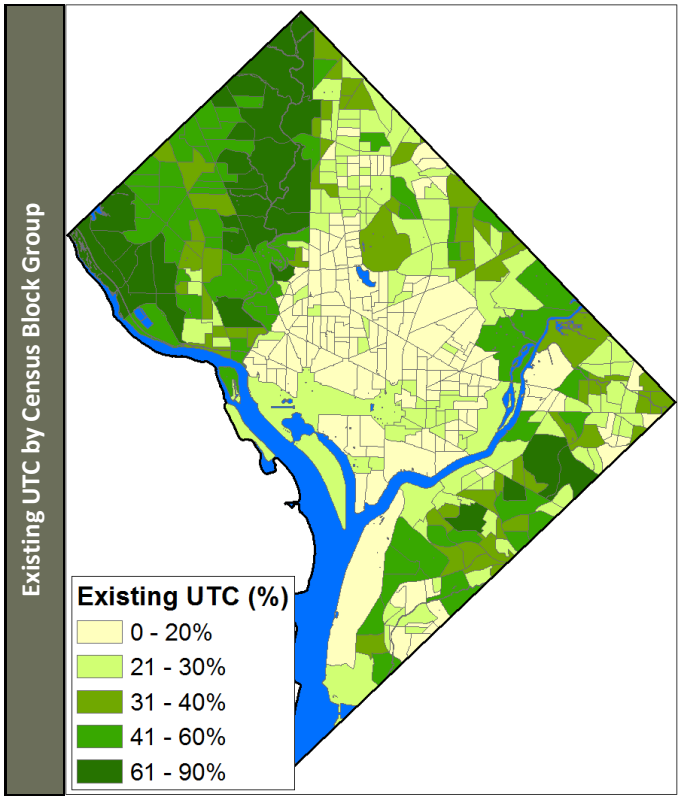

Figure 7a: Existing UTC, expressed as the percentage of land area, for U.S. Census block groups.

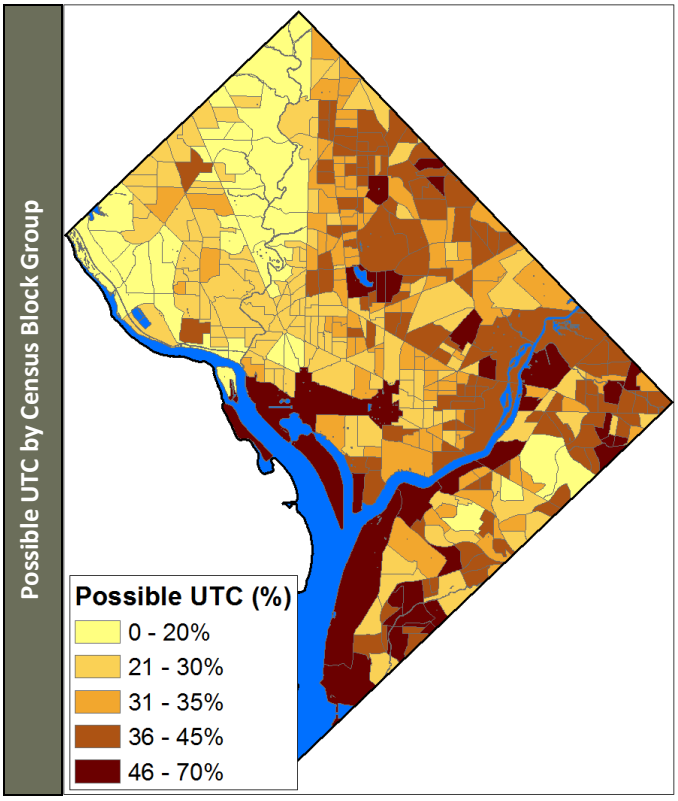

Figure 7b: Possible UTC, expressed as the percentage of land area, for U.S. Census block groups.

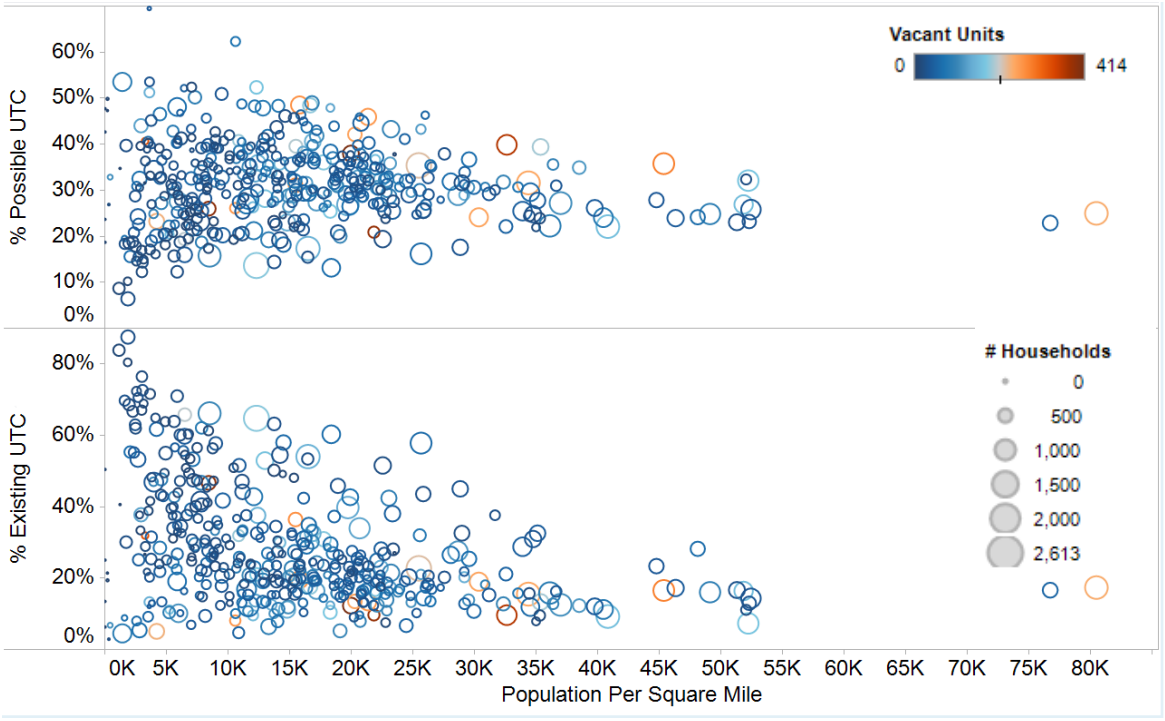

Figure 8: UTC metrics in relation to block group-level census data. Displaying UTC data in this manner facilitates the process of targeting block groups for tree-planting initiatives based on high proportions of Possible UTC and high population density. In this case, comparison of UTC metrics to the number of households highlights block groups that may serve as fertile ground for citizen tree-care initiatives while comparison to vacant units suggests where such initiatives might be hampered by neighborhood instability.

Environmental Analysis

Many different environmental variables can be factored into UTC assessments, including watersheds, storm sewer systems, and other features that influence stormwater runoff. By watershed, for example, Rock Creek has among the largest volume of Existing UTC by both total and proportional area (Figure 9, 10a). Although the Anacostia River watershed contains a similarly large total area of Existing UTC, it contains a higher proportion of Possible UTC (Figure 10b). This watershed also contains the largest area of lands not suited to UTC enhancement (e.g., permanent structures, roads). The southern portion of the Potomac River watershed (the Four Mile Run-Potomac River subwatershed) has the highest proportion of Possible UTC in the city.

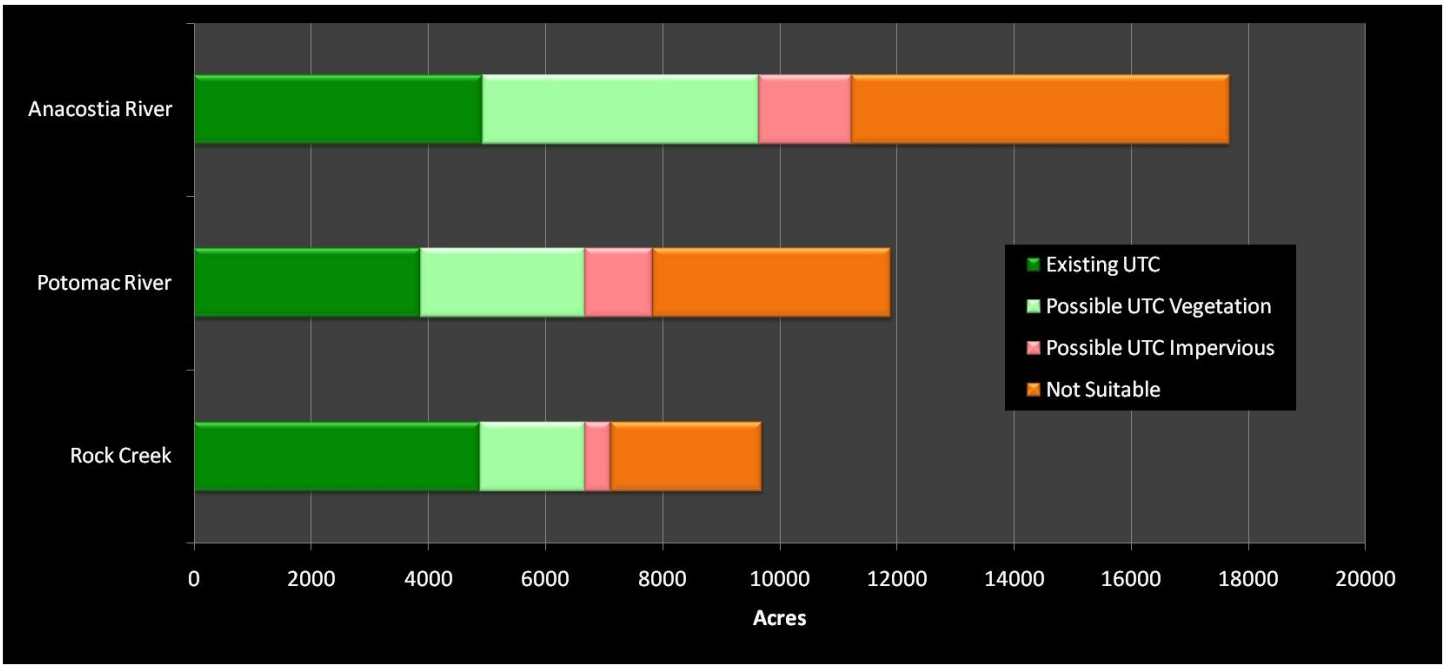

Figure 9: Distribution of existing and possible urban tree canopy in Washington, D.C. watersheds (aggregated 12-digit hydrological units).

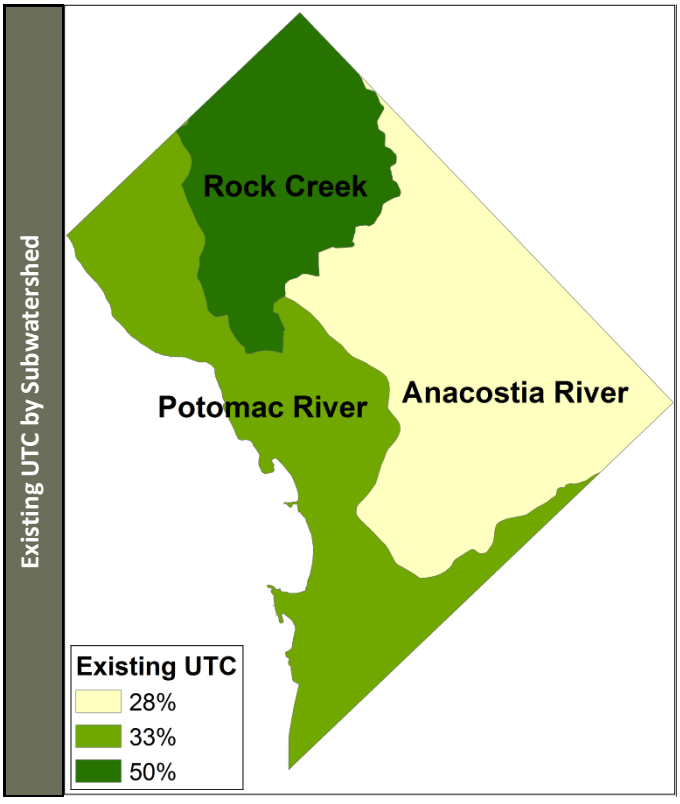

Figure 10a: Existing UTC, expressed as the percentage of land area, for major subwatersheds.

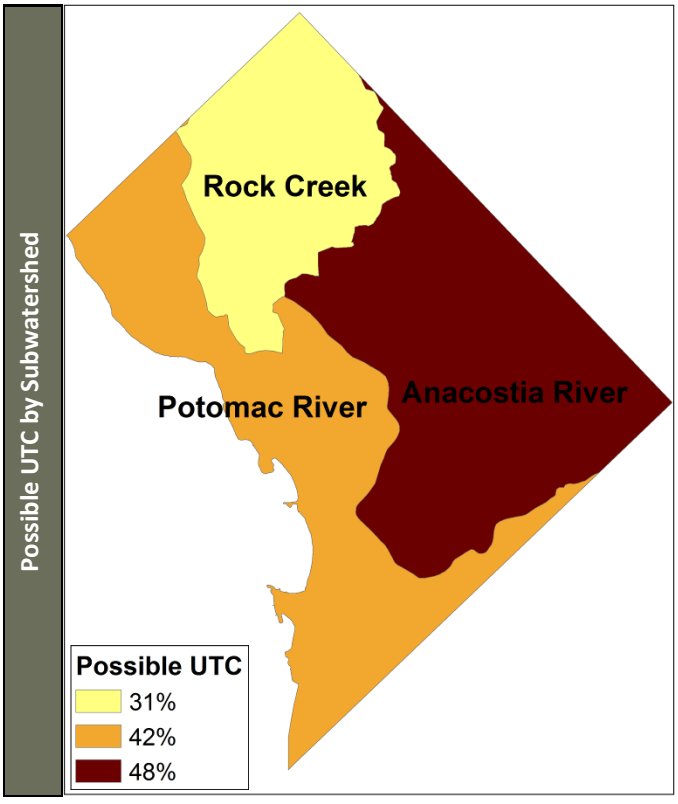

Figure 10b: Possible UTC, expressed as the percentage of land area, for major subwatersheds.

Analysis of District of Columbia Wards

Political units can also be considered in UTC assessments to further help gauge the distribution of the urban forest. In Washington's wards, for example, Wards 3 and 4 in Northwest Washington currently have the highest volume of tree canopy , both in total acreage and as a percentage of land area (Figures 11, 12a). Not surprisingly, these wards have relatively low proportions of Possible UTC (Figure 12b). In contrast, Wards 1, 2, and 6 have the smallest area of Existing UTC. Note, however, that the relationship between Existing and Possible UTC is not necessarily inversely proportional; wards with a heavily-clumped distribution of land-use types may have relatively high volumes of both UTC types. For example, Ward 8 has a high volume of Possible UTC along the Potomac River but is more heavily forested in its eastern sections.

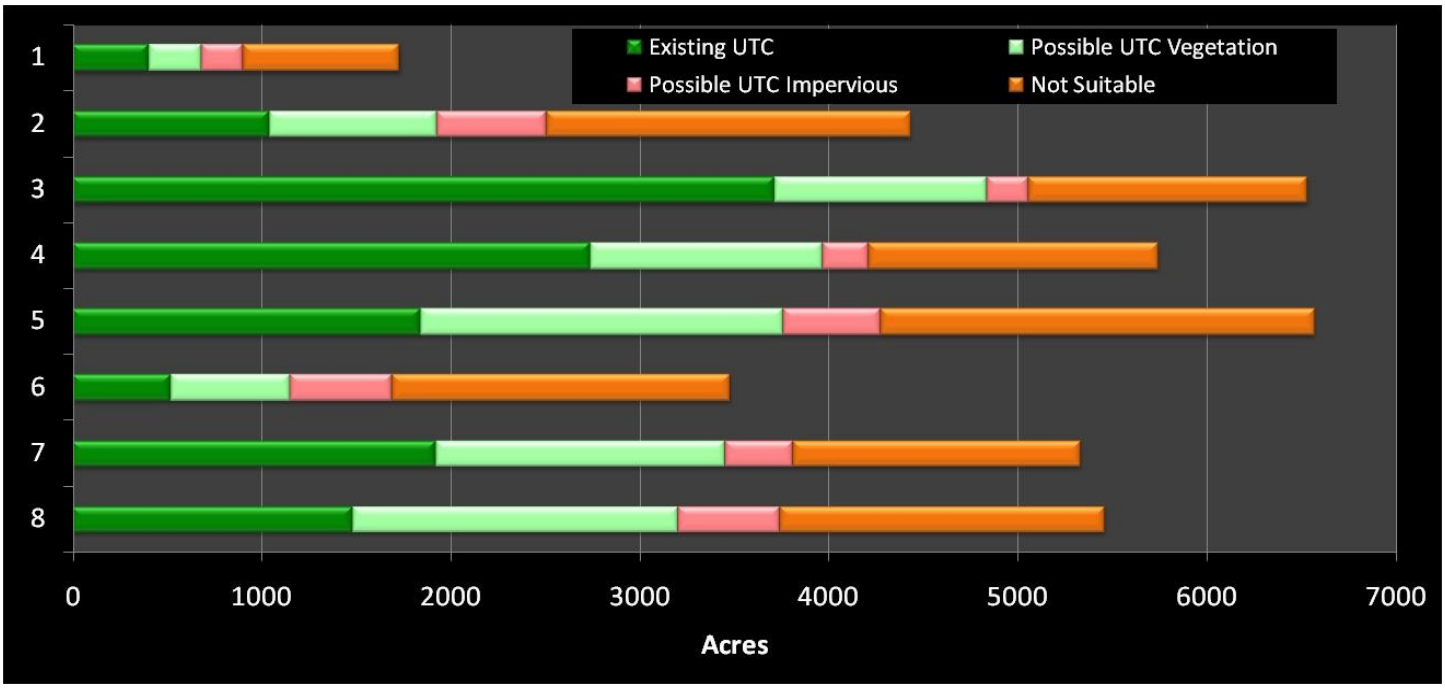

Figure 11: Distribution of existing and possible urban tree canopy in Washington, D.C. wards.

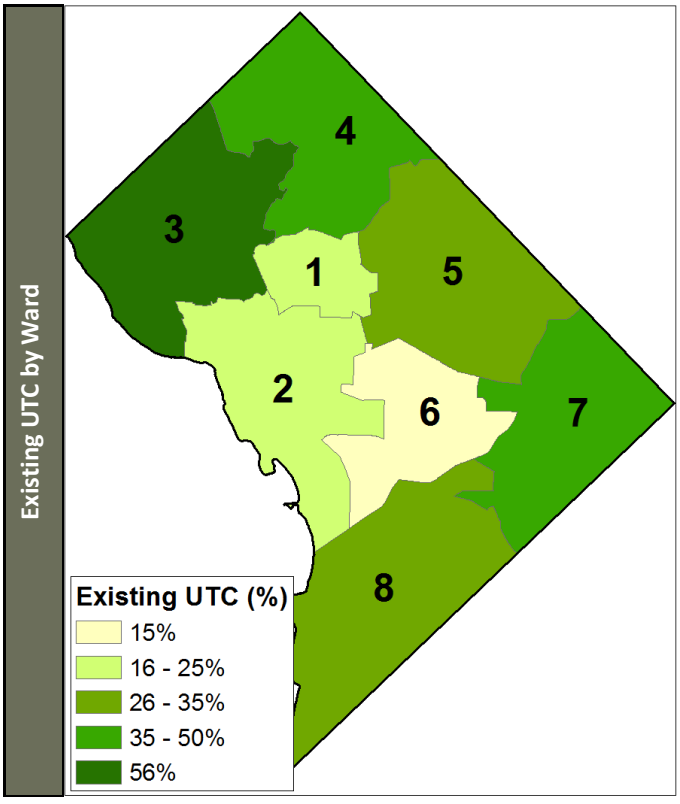

Figure 12a: Existing UTC, expressed as the percentage of land area, for wards.

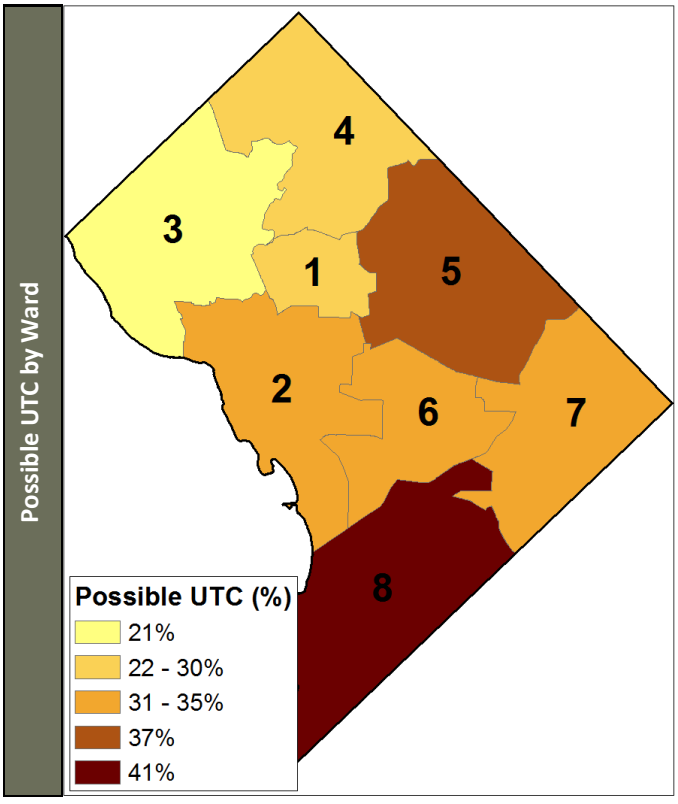

Figure 12b: Possible UTC, expressed as the percentage of land area, for wards.

Analysis of Advisory Neighborhood Commissions

Another example of potential analyses with political units involves Advisory Neighborhood Commissions (ANCs). Patterns similar to those with voting wards emerge with ANCs, but the finer-scale and more numerous units produce a broader distribution. ANCs encompassing all or parts of parks like Rock Creek and Fort DuPont (e.g., 3G in Northwest and 7B in Southeast) predictably include large total areas and proportions of Existing UTC while those in the city center (e.g., 2B) contain less (Figures 13, 14a). Because the city center generally includes land uses not suitable for UTC expansion, its ANCs also tend to have less Possible UTC (Figure 14b). ANCs with the highest proportion of Possible UTC include non-forested open space lands along the Potomac River, industrial sites in Southwest Washington, and neighborhoods in Northeast.

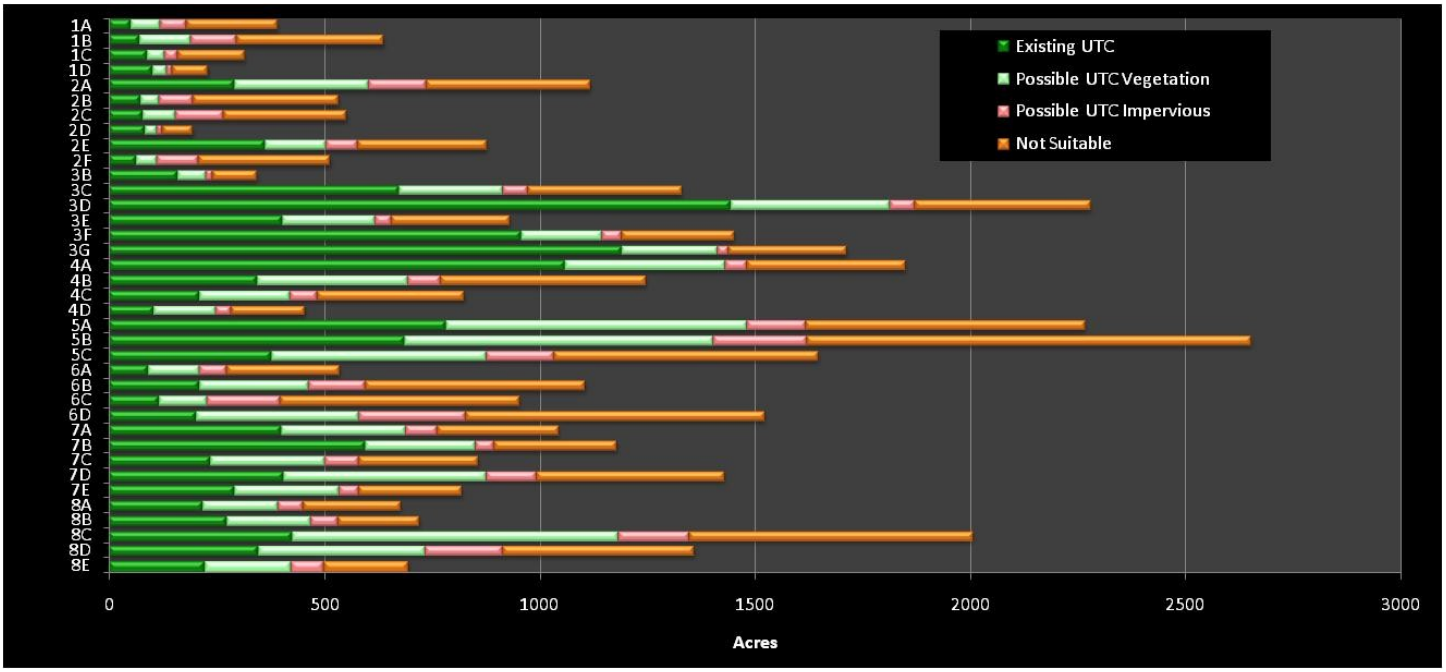

Figure 13: Distribution of existing and possible urban tree canopy in Washington, D.C. Advisory Neighborhood Commissions.

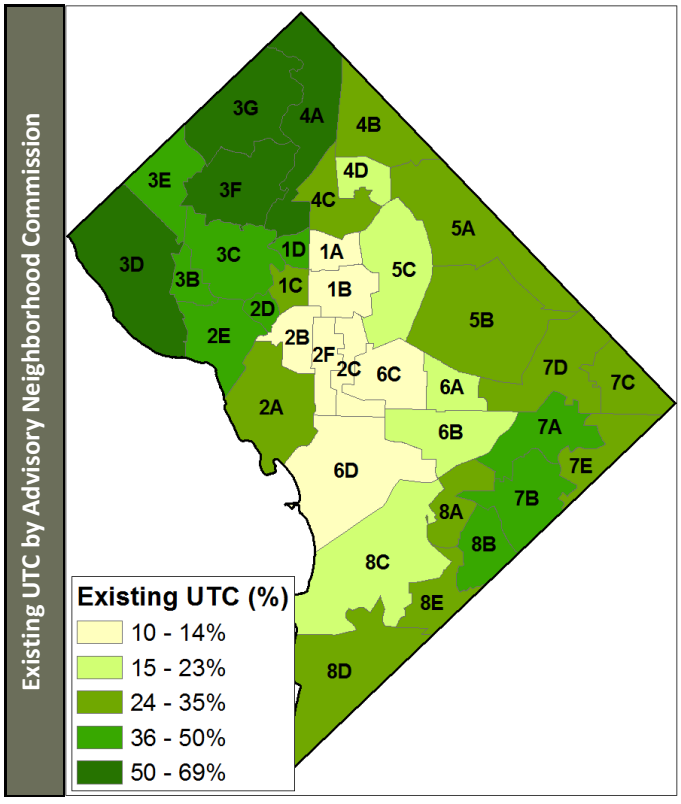

Figure 14a: Existing UTC, expressed as the percentage of land area, for Advisory Neighborhood Commissions.

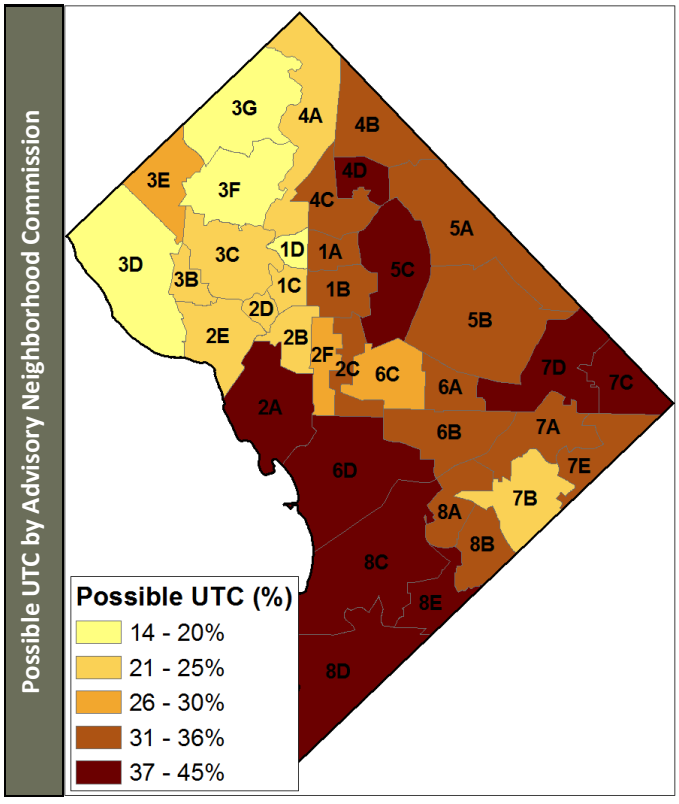

Figure 14b: Possible UTC, expressed as the percentage of land area, for Advisory Neighborhood Commissions.

Conclusions & Recommendations

- Existing tree canopy is not evenly distributed in the city's residential areas, with medium– and high-density residential land-use classes under-represented. Although these classes occupy a much smaller proportion of the city's land area, they should be included in UTC planning efforts.
- UTC goals for Washington should not be limited to increasing the city's overall tree canopy; they should also focus on increasing tree canopy in those parcels or blocks that have the least Existing UTC and highest Possible UTC. This targeted effort can be performed using the UTC parcel database that was produced as part of this assessment.
- By land-use type, Washington's residents control the largest percentage of Possible UTC. Programs that educate residents on tree stewardship and provide incentives for tree planting are essential if Washington is to sustain its tree canopy in the long term.
- Other land-use types (e.g., parks and recreation, non-park Federal, institutional, commercial) also offer ample opportunity for UTC improvements. Because these parcels are generally larger in size, and in some cases under government control, the opportunity exists to engage more directly in large-scale greening initiatives.
- Of particular focus for UTC improvement should be parcels in the city that have large, contiguous impervious surfaces. These parcels contribute high amounts of runoff, degrading water quality. The establishment of tree canopy on these parcels will help reduce runoff during periods of peak overland flow, especially in the combined sewer overflow (CSO) area of the city.

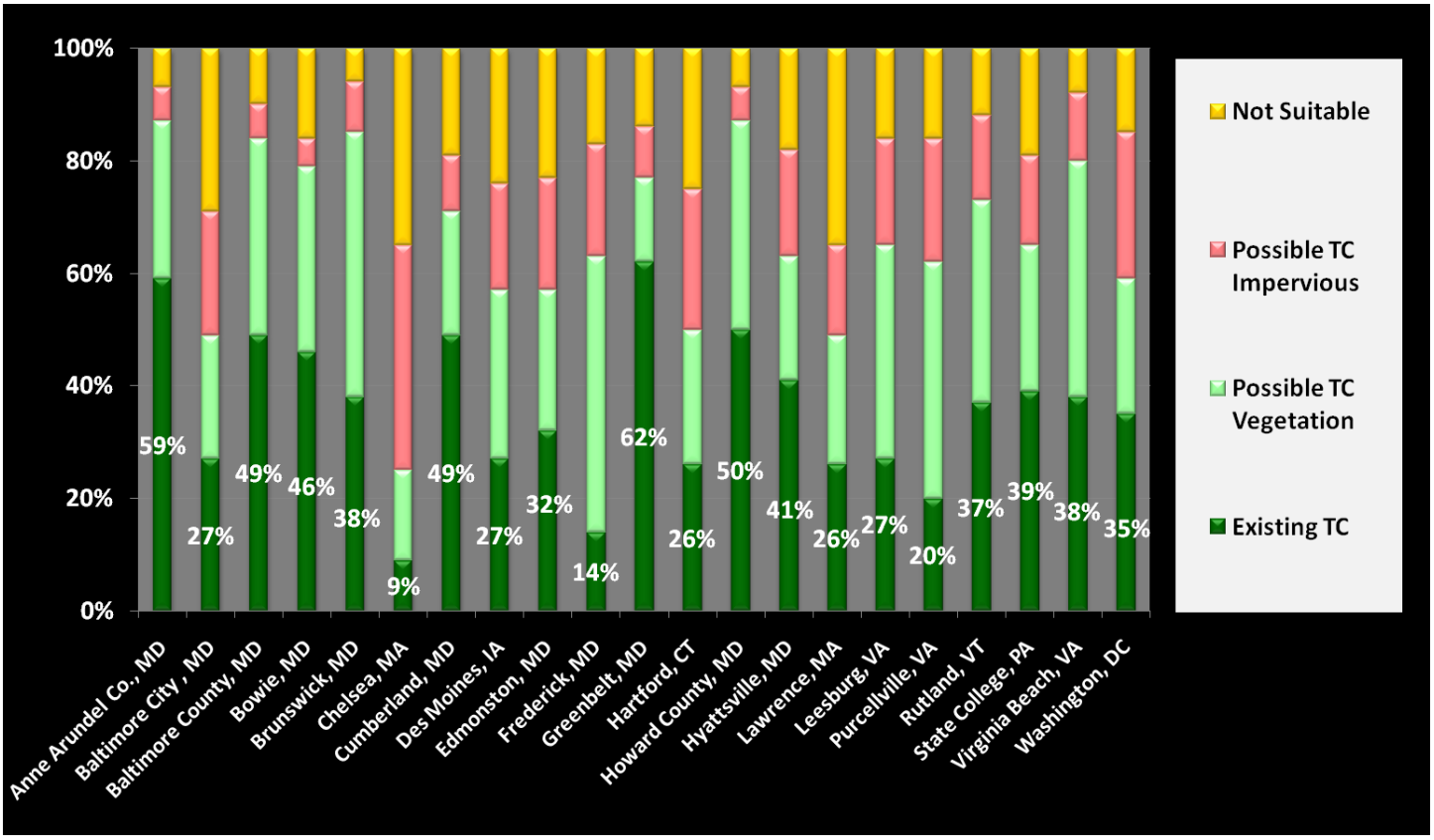

Figure 15: Comparison of Existing UTC in selected cities that have also completed UTC assessments.

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Additional Information

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http://nrs.fs.fed.us/urban/utc/